

Legacy Device: Motorola MC12013

This device is a two-modulus prescaler which will divide by 10 and 11. A MECL-to-MTTL translator is provided to interface directly with the MC12014 Counter Control Logic. In addition, there is a buffered clock input and MECL bias voltage source.

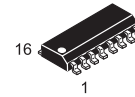
- 550 MHz ($\div 10/11$)
- MECL to MTTL Translator on Chip
- MECL and MTTL Enable Inputs
- 5.0 or -5.2 V Operation*
- Buffered Clock Input — Series Input RC Typ, 20 Ω and 4.0 pF
- V_{BB} Reference Voltage
- 310 Milliwatts (Typ)

* When using a 5.0 V supply, apply 5.0 V to Pin 1 (V_{CCO}), Pin 6 (MTTL V_{CC}), Pin 16 (V_{CC}), and ground Pin 8 (V_{EE}). When using -5.2 V supply, ground Pin 1 (V_{CCO}), Pin 6 (MTTL V_{CC}), and Pin 16 (V_{CC}) and apply -5.2 V to Pin 8 (V_{EE}). If the translator is not required, Pin 6 may be left open to conserve DC power drain.

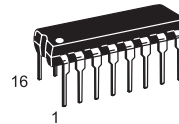
MAXIMUM RATINGS

Characteristic	Symbol	Rating	Unit
(Ratings above which device life may be impaired)			
Power Supply Voltage ($V_{CC} = 0$)	V_{EE}	-8.0	Vdc
Input Voltage ($V_{CC} = 0$)	V_{in}	0 to V_{EE}	Vdc
Output Source Current Continuous Surge	I_O	< 50 < 100	mAdc
Storage Temperature Range	T_{stg}	-65 to 175	$^{\circ}C$
(Recommended Maximum Ratings above which performance may be degraded)			
Operating Temperature Range	T_A	-40 to +85	$^{\circ}C$
DC Fan-Out (Note 1) (Gates and Flip-Flops)	n	70	-

NOTES: 1. AC fan-out is limited by desired system performance.



SO 16 = -5P
PLASTIC PACKAGE
CASE 751B
(SO-16)



P DIP 16 = EP
PLASTIC PACKAGE
CASE 648

CROSS REFERENCE/ORDERING INFORMATION

PACKAGE	MOTOROLA	LANSDALE
P DIP 16	MC12013P	ML12013EP
SOIC 16	MC12013D	ML12013-5P

Note: Lansdale lead free (**Pb**) product, as it becomes available, will be identified by a part number prefix change from **ML** to **MLE**.

PIN CONNECTIONS

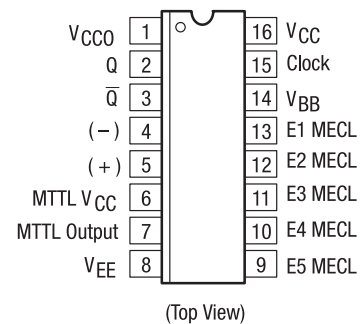


Figure 1. Logic Diagrams

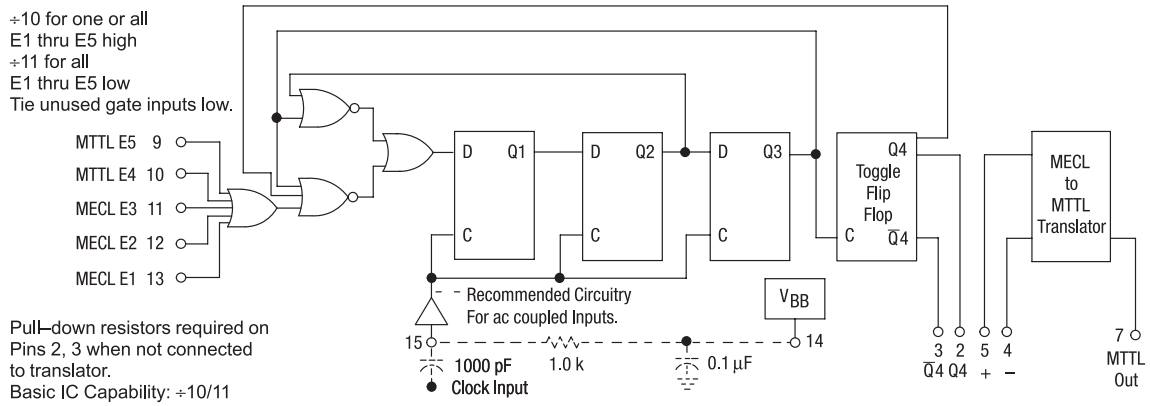


Figure 2a. Typical Frequency Synthesizer Application

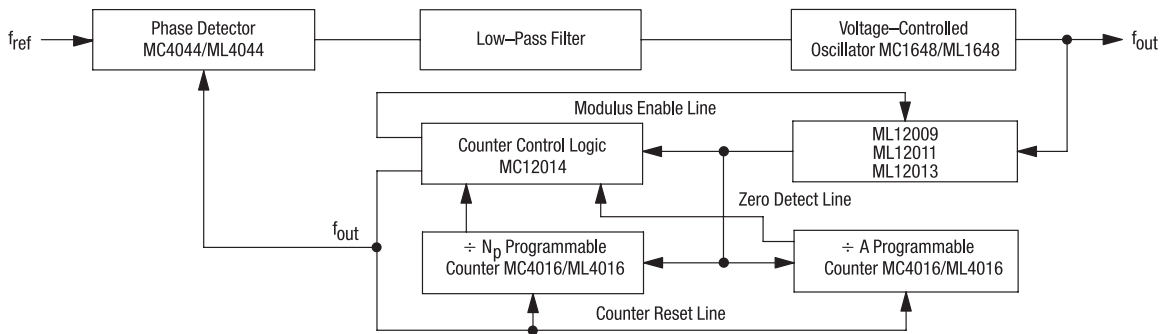


Figure 2b Generic block diagram showing prescaler connection to PLL Device

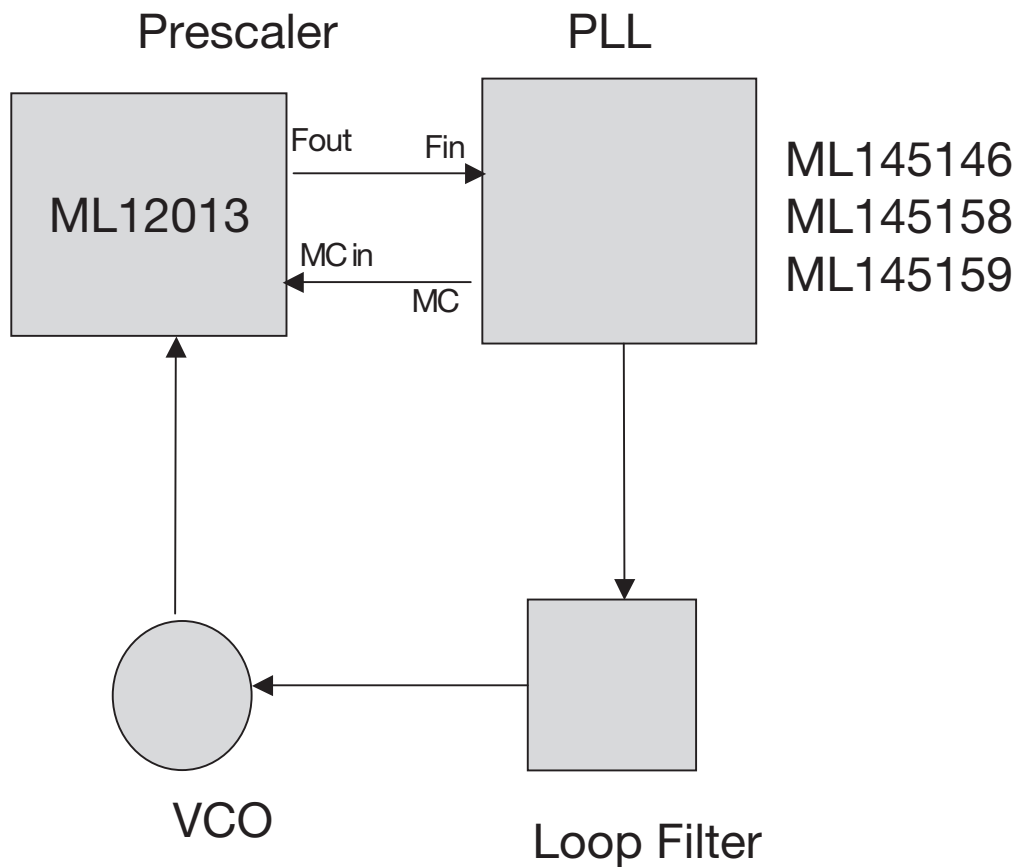


Figure 2b shows a generic block diagram of connecting a prescaler to a PLL device that supports dual modulus control. Application note An535 describes using a two-modulus prescaler technique by using prescaler higher frequencies can be achieved than by a single CMOS PLL device

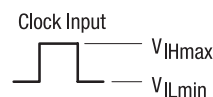
ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.)

Characteristic	Symbol	Pin Under Test	Test Limits						Unit
			-40°C		25°C		85°C		
			Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I _{CC1}	8	-88		-80		-80		mAdc
	I _{CC2}	6		5.2		5.2		5.2	mAdc
Input Current	I _{inH1}	15		375		250		250	μAdc
		11		375		250		250	
		12		375		250		250	
		13		375		250		250	
	I _{inH2}	4	1.7	6.0	2.0	6.0	2.0	6.4	mAdc
		5	1.7	6.0	2.0	6.0	2.0	6.4	
	I _{inH3}	5	0.7	3.0	1.0	3.0	1.0	3.6	μAdc
	I _{inH4}	9		100		100		100	
		10		100		100		100	
Leakage Current	I _{inL1}	15	-10		-10		-10		μAdc
		11	-10		-10		-10		
		12	-10		-10		-10		
		13	-10		-10		-10		
	I _{inL2}	9	-1.6		-1.6		-1.6		mAdc
		10	-1.6		-1.6		-1.6		
Reference Voltage	V _{BB}	14			-1.360	-1.160		Vdc	
Logic '1' Output Voltage	V _{OH1} (Note 1)	2	-1.100	-0.890	-1.000	-0.810	-0.930	-0.700	Vdc
		3	-1.100	-0.890	-1.000	-0.810	-0.930	-0.700	
	V _{OH2}	7	-2.8		-2.6		-2.4		
Logic '0' Output Voltage	V _{OL1} (Note 1)	2	-1.990	-1.675	-1.950	-1.650	-1.925	-1.615	Vdc
		3	-1.990	-1.675	-1.950	-1.650	-1.925	-1.615	
	V _{OL2}	7		-4.26		-4.40		-4.48	
Logic '1' Threshold Voltage	V _{OHA} (Note 2)	2	-1.120		-1.020		-0.950		Vdc
		3	-1.120		-1.020		-0.950		
Logic '0' Threshold Voltage	V _{OLA} (Note 3)	2		-1.655		-1.630		-1.595	Vdc
		3		-1.655		-1.630		-1.595	
Short Circuit Current	I _{OS}	7	-65	-20	-65	-20	-65	-20	mAdc

NOTES: 1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.

2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.

3. In addition to meeting the output levels specified, the device must divide by 11 during this test. The clock input is the waveform shown.

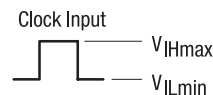


Each MECL 10,000 series circuit has been designed to meet the dc specifications shown in the test table, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained. Outputs are terminated through a 50 Ω resistor to -2.0 V. Test procedures are shown for only one gate. The other gates are tested in the same manner.

ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						Gnd
			Volts						
			V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{ILH}	
			@ Test Temperature	-40°C	25°C	85°C	-0.890	-1.990	
			TEST VOLTAGE APPLIED TO PINS LISTED BELOW						
Characteristic	Symbol	Pin Under Test	V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{IL}	Gnd
Power Supply Drain Current	I_{CC1}	8							1,16
	I_{CC2}	6	4	5					6
Input Current	I_{inH1}	15	15						1,16
		11	11						1,16
		12	12						1,16
		13	13						1,16
	I_{inH2}	4	5	4					6
		5	5	4					6
I_{inH3}	5	4	5					6	
I_{inH4}	9					9		1,16	
	10					10		1,16	
Leakage Current	I_{inL1}	15							1,16
		11							1,16
		12							1,16
		13							1,16
I_{inL2}	9						9	1,16	
	10						10	1,16	
Reference Voltage	V_{BB}	14						1,16	
Logic '1' Output Voltage	V_{OH1} (Note 1)	2		11,12,13				9,10	1,16
		3		11,12,13				9,10	1,16
V_{OH2}	7	5	4					6	
Logic '0' Output Voltage	V_{OL1} (Note 1)	2		11,12,13				9,10	1,16
		3		11,12,13				9,10	1,16
	V_{OL2}	7	4	5					6
Logic '1' Threshold Voltage	V_{OHA} (Note 2)	2			11,12,13				1,16
		3			11,12,13				1,16
Logic '0' Threshold Voltage	V_{OLA} (Note 3)	2				11,12,13			1,16
		3				11,12,13			1,16
Short Circuit Current	I_{OS}	7	5	4				7	6

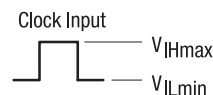
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 2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.
 3. In addition to meeting the output levels specified, the device must divide by 11 during this test. The clock input is the waveform shown.



ELECTRICAL CHARACTERISTICS (Supply Voltage = -5.2 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						Gnd
			Volts			mA			
			V_{IHT}	V_{ILT}	V_{EE}	I_L	I_{OL}	I_{OH}	
			@ Test Temperature						
		-40°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
		25°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
		85°C	-3.2	-4.4	-5.2	-0.25	16	-0.40	
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						Gnd
			V_{IHT}	V_{ILT}	V_{EE}	I_L	I_{OL}	I_{OH}	
Power Supply Drain Current	I_{CC1}	8			8				1,16
	I_{CC2}	6			8				6
Input Current	I_{inH1}	15			8				1,16
		11	9,10		8				1,16
		12	9,10		8				1,16
		13	9,10		8				1,16
	I_{inH2}	4			8				6
		5			8				6
	I_{inH3}	5			8				6
I_{inH4}	9			8				1,16	
	10			8				1,16	
Leakage Current	I_{inL1}	15			8,15				1,16
		11			8,11				1,16
		12			8,12				1,16
		13			8,13				1,16
	I_{inL2}	9			8				1,16
10				8				1,16	
Reference Voltage	V_{BB}	14			8	14			1,16
Logic '1' Output Voltage	V_{OH1} (Note 1)	2			8				1,16
		3			8				1,16
V_{OH2}	7			8			7	6	
Logic '0' Output Voltage	V_{OL1} (Note 1)	2			8				1,16
		3			8				1,16
	V_{OL2}	7			8		7		6
Logic '1' Threshold Voltage	V_{OHA} (Note 2)	2	9,10		8				1,16
		3	9,10		8				1,16
Logic '0' Threshold Voltage	V_{OLA} (Note 3)	2		9,10	8				1,16
		3		9,10	8				1,16
Short Circuit Current	I_{OS}	7			8				6

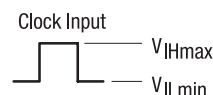
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2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.
3. In addition to meeting the output levels specified, the device must divide by 11 during this test. The clock input is the waveform shown.



ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.)

Characteristic	Symbol	Pin Under Test	Test Limits						Unit
			-40°C		25°C		85°C		
			Min	Max	Min	Max	Min	Max	
Power Supply Drain Current	I _{CC1}	8	-88		-80		-80		mAdc
	I _{CC2}	6		5.2		5.2		5.2	mAdc
Input Current	I _{inH1}	15		375		250		250	μAdc
		11		375		250		250	
		12		375		250		250	
		13		375		250		250	
	I _{inH2}	4	1.7	6.0	2.0	6.0	2.0	6.4	mAdc
		5	1.7	6.0	2.0	6.0	2.0	6.4	
	I _{inH3}	5	0.7	3.0	1.0	3.0	1.0	3.6	
	I _{inH4}	9			100	100		100	μAdc
10				100	100		100		
Leakage Current	I _{inL1}	15	-10		-10		-10		μAdc
		11	-10		-10		-10		
		12	-10		-10		-10		
		13	-10		-10		-10		
	I _{inL2}	9	-1.6		-1.6		-1.6		mAdc
		10	-1.6		-1.6		-1.6		
Reference Voltage	V _{BB}	14			3.67	3.87		Vdc	
Logic '1' Output Voltage	V _{OH1} (Note 1)	2	3.900	4.110	4.000	4.190	4.070	4.300	Vdc
		3	3.900	4.110	4.000	4.190	4.070	4.300	
	V _{OH2}	7	2.4		2.6		2.8		
Logic '0' Output Voltage	V _{OL1} (Note 1)	2	3.070	3.385	3.110	3.410	3.135	3.445	Vdc
		3	3.070	3.385	3.110	3.410	3.135	3.445	
	V _{OL2}	7		0.94		0.80		0.72	
Logic '1' Threshold Voltage	V _{OHA} (Note 2)	2	3.880		3.980		4.050		Vdc
		3	3.880		3.980		4.050		
Logic '0' Threshold Voltage	V _{OLA} (Note 3)	2		3.405		3.430		3.465	Vdc
		3		3.405		3.430		3.465	
Short Circuit Current	I _{OS}	7	-65	-20	-65	-20	-65	-20	mAdc

- NOTES:** 1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
 2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.
 3. In addition to meeting the output levels specified, the device must divide by 11 during this test. The clock input is the waveform shown.

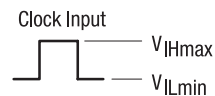


Each MECL 10,000 series circuit has been designed to meet the dc specifications shown in the test table, after thermal equilibrium has been established. The circuit is in a test socket or mounted on a printed circuit board and transverse air flow greater than 500 linear fpm is maintained. Outputs are terminated through a 50 Ω resistor to -2.0 V. Test procedures are shown for only one gate. The other gates are tested in the same manner.

ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES							
			Volts							
			V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{ILH}		
			@ Test Temperature							
			-40°C	4.110	3.070	3.795	3.500	2.4	0.5	
			25°C	4.190	3.110	3.895	3.525	2.4	0.5	
			85°C	4.300	3.135	3.965	3.560	2.4	0.5	
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						(V _{EE}) Gnd	
			V_{IHmax}	V_{ILmin}	V_{IHmin}	V_{ILmax}	V_{IH}	V_{IL}		
Power Supply Drain Current	I _{CC1}	8							8	
	I _{CC2}	6	4	5					8	
Input Current	I _{inH1}	15	15						8	
		11	11						8	
		12	12						8	
		13	13						8	
	I _{inH2}	4	5	4					8	
		5	5	4					8	
I _{inH3}	5	4	5					8		
I _{inH4}	9					9		8		
	10					10		8		
Leakage Current	I _{inL1}	15						8,15		
		11						8,11		
12							8,12			
13							8,13			
I _{inL2}	9						9	8		
	10						10	8		
Reference Voltage	V _{BB}	14						8		
Logic '1' Output Voltage	V _{OH1} (Note 1)	2		11,12,13				9,10	8	
		3		11,12,13				9,10	8	
	V _{OH2}	7	5	4				8		
Logic '0' Output Voltage	V _{OL1} (Note 1)	2		11,12,13				9,10	8	
		3		11,12,13				9,10	8	
	V _{OL2}	7	4	5				8		
Logic '1' Threshold Voltage	V _{OHA} (Note 2)	2			11,12,13				8	
		3			11,12,13				8	
Logic '0' Threshold Voltage	V _{OLA} (Note 3)	2				11,12,13			8	
		3				11,12,13			8	
Short Circuit Current	I _{OS}	7	5	4				7	8	

- NOTES:** 1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.
 2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.
 3. In addition to meeting the output levels specified, the device must divide by 11 during this test. The clock input is the waveform shown.



ELECTRICAL CHARACTERISTICS (Supply Voltage = 5.0 V, unless otherwise noted.) (continued)

			TEST VOLTAGE/CURRENT VALUES						(V _{EE}) Gnd
			Volts			mA			
			V _{IHT}	V _{ILT}	V _{CC}	I _L	I _{OL}	I _{OH}	
			@ Test Temperature						
			-40°C						
			25°C						
			85°C						
Characteristic	Symbol	Pin Under Test	TEST VOLTAGE APPLIED TO PINS LISTED BELOW						(V _{EE}) Gnd
			V _{IHT}	V _{ILT}	V _{CC}	I _L	I _{OL}	I _{OH}	
Power Supply Drain Current	I _{CC1}	8			1,16				8
	I _{CC2}	6			6				8
Input Current	I _{inH1}	15			1,16				8
		11	9,10		1,16				8
		12	9,10		1,16				8
		13	9,10		1,16				8
	I _{inH2}	4			6				8
		5			6				8
	I _{inH3}	5			6				8
	I _{inH4}	9			1,16				8
10				1,16				8	
Leakage Current	I _{inL1}	15			1,16				8,15
		11			1,16				8,11
		12			1,16				8,12
		13			1,16				8,13
	I _{inL2}	9			1,16				8
		10			1,16				8
Reference Voltage	V _{BB}	14			1,16	14			8
Logic '1' Output Voltage	V _{OH1} (Note 1)	2			1,16				8
		3			1,16				8
	V _{OH2}	7			6		7		8
Logic '0' Output Voltage	V _{OL1} (Note 1)	2			1,16				8
		3			1,16				8
	V _{OL2}	7			6		7		8
Logic '1' Threshold Voltage	V _{OHA} (Note 2)	2	9,10		1,16				8
		3	9,10		1,16				8
Logic '0' Threshold Voltage	V _{OLA} (Note 3)	2		9,10	1,16				8
		3		9,10	1,16				8
Short Circuit Current	I _{OS}	7			6				8

NOTES: 1. Test outputs of the device must be tested by sequencing through the truth table. All input, power supply and ground voltages must be maintained between tests. The clock input is the waveform shown.

2. In addition to meeting the output levels specified, the device must divide by 10 during this test. The clock input is the waveform shown.

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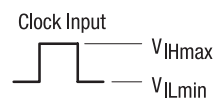


Figure 5. AC Test Circuit

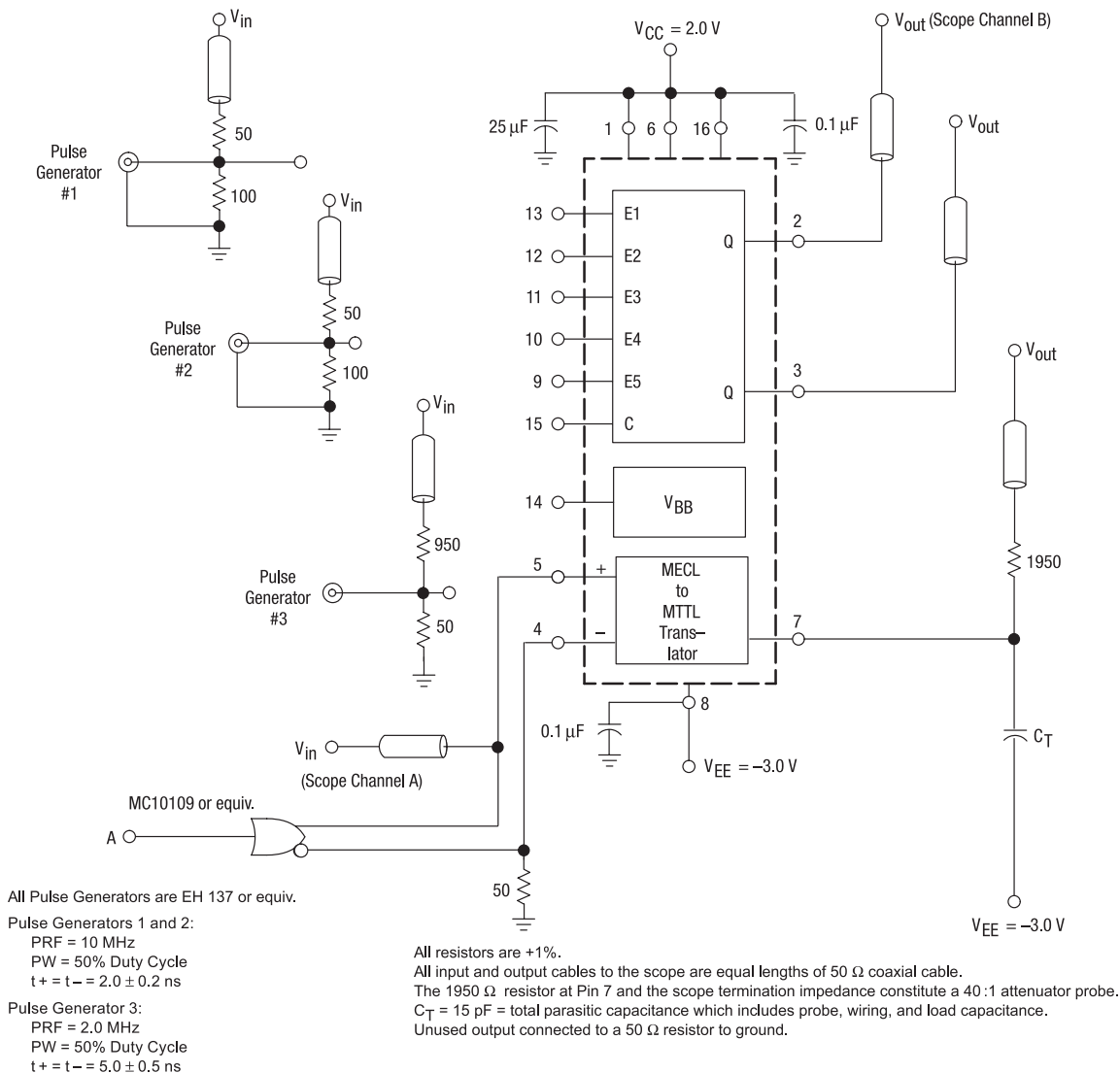
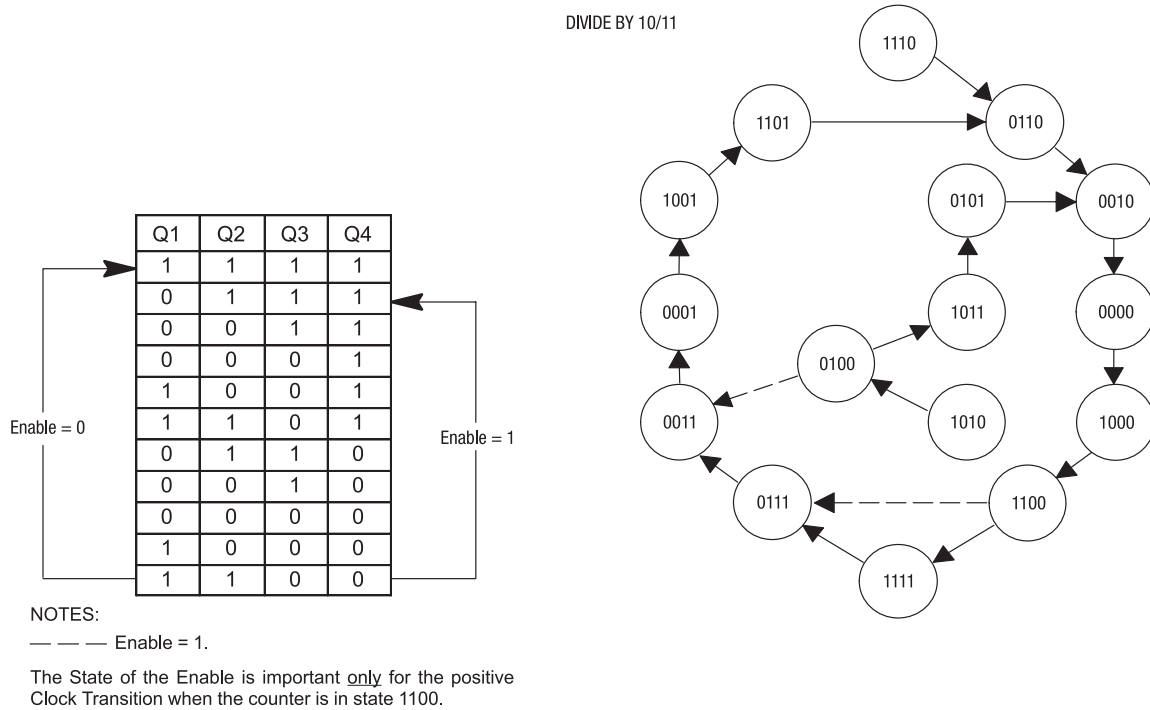


Figure 7. State Diagram



APPLICATIONS INFORMATION

The primary application of this device is as a high-speed variable modulus prescaler in the divide by N section of a phase-locked loop synthesizer used as the local oscillator of two-way radios.

Proper VHF termination techniques should be followed when the clock is separated from the prescaler by any appreciable distance.

In it's basic form, this device will divide by 10/11. Division

by 10 occurs when any one or all of the five gate inputs E1 through E5 are high. Division by 11 occurs when all inputs E1 through E5 are low. (Unconnected MTTL inputs are normally high, unconnected MECL inputs are normally low). With the addition of extra parts, many different division configurations may be obtained (20/21, 40/41, 50/51, 100/101, etc.) A few of the many configurations are shown below.

Figure 8. Divide By 10/11

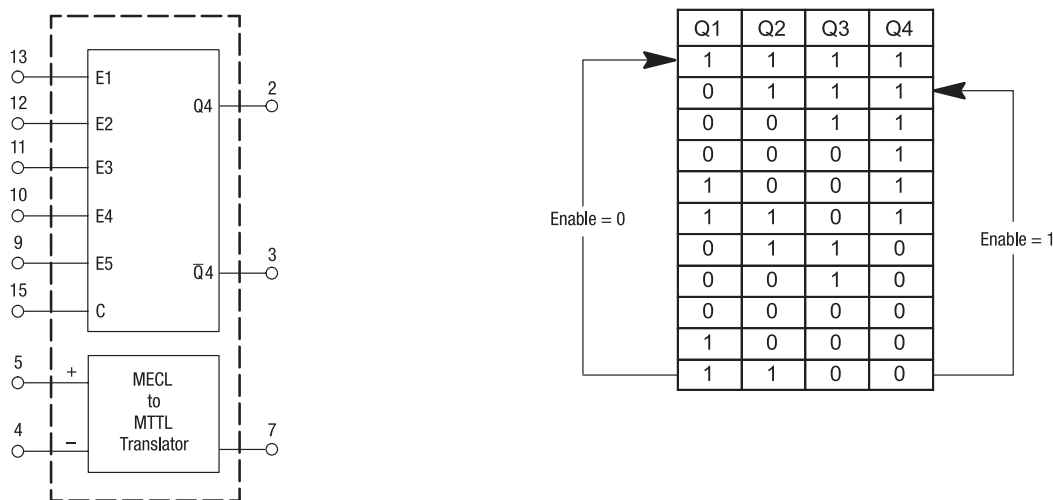
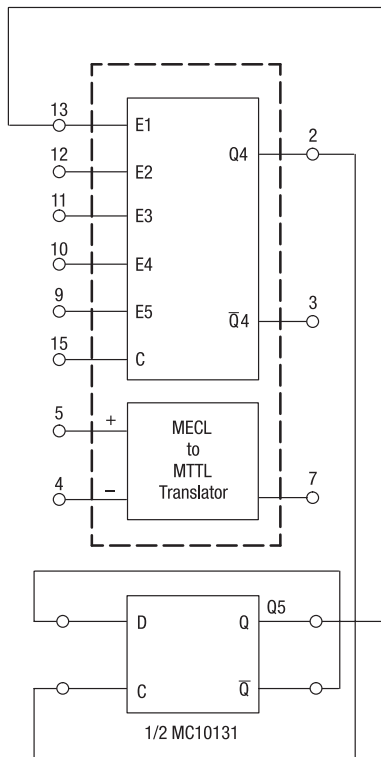


Figure 9. Divide By 20/21

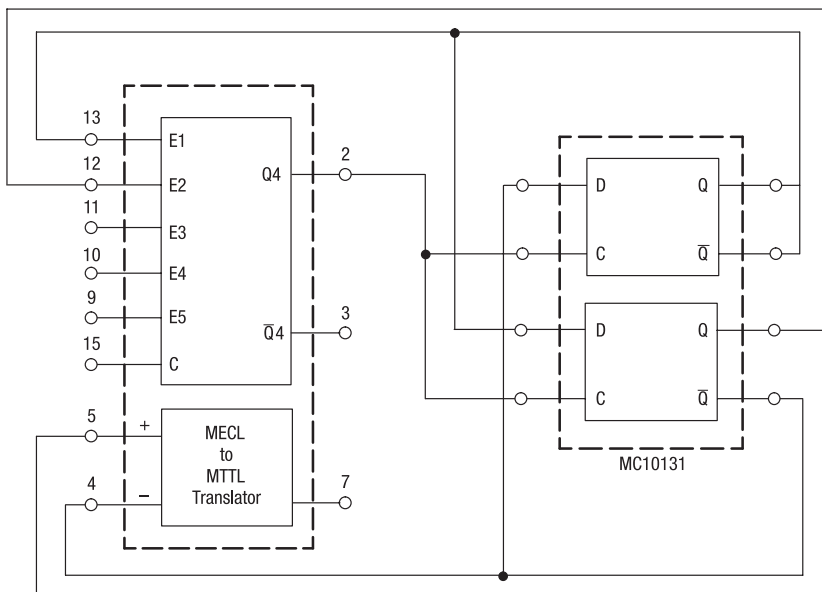


COUNT	Q1	Q2	Q3	Q4	Q4
31	1	1	1	1	1
30	0	1	1	1	1
28	0	0	1	1	1
24	0	0	0	1	1
25	1	0	0	1	1
27	1	1	0	1	1
22	0	1	1	0	1
20	0	0	1	0	1
16	0	0	0	0	1
17	1	0	0	0	1
19	1	1	0	0	1
14	0	1	1	1	0
12	0	0	1	1	0
8	0	0	0	1	0
9	1	0	0	1	0
11	1	1	0	1	0
6	0	1	1	0	0
4	0	0	1	0	0
0	0	0	0	0	0
1	1	0	0	0	0
3	1	1	0	0	0

To obtain an MTTL output, connect Pins 5 and 4 to Pins 2 and 3, respectively. Termination resistors for the MECL outputs are not shown, but are required except for the flip-flop driving the translator section.

The ÷ 20/21 counter may also be built using an MTTL flip-flop by connecting Pins 5 and 4 to Pins 2 and 3 respectively, and driving the MTTL flip-flop with Pin 7. ML12013 inputs E4 and E5 are used rather than E1. With $E1 + E2 + E3 = 0$, operation remains as shown.

Figure 10. Divide By 40/41



For ÷ 40 : $E4 + E5 = 1$
 For ÷ 41 : $E4 + E5 = 0$

Termination resistors for MECL outputs are not shown, but are required except for the flip-flop driving the translator section.

OUTLINE DIMENSIONS

SO 16 = -5P
PLASTIC PACKAGE
 (ML12013-5P)
 CASE 751B-05
 (SO-16)
 ISSUE J

NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: MILLIMETER.
 3. DIMENSIONS A AND B DO NOT INCLUDE MOLD PROTRUSION.
 4. MAXIMUM MOLD PROTRUSION 0.15 (0.006) PER SIDE.
 5. DIMENSION D DOES NOT INCLUDE DAMBAR PROTRUSION. ALLOWABLE DAMBAR PROTRUSION SHALL BE 0.127 (0.005) TOTAL IN EXCESS OF THE D DIMENSION AT MAXIMUM MATERIAL CONDITION.

DIM	MILLIMETERS		INCHES	
	MIN	MAX	MIN	MAX
A	9.80	10.00	0.386	0.393
B	3.80	4.00	0.150	0.157
C	1.35	1.75	0.054	0.068
D	0.35	0.49	0.014	0.019
F	0.40	1.25	0.016	0.049
G	1.27 BSC		0.050 BSC	
J	0.19	0.25	0.008	0.009
K	0.10	0.25	0.004	0.009
M	0°	7°	0°	7°
P	5.80	6.20	0.229	0.244
R	0.25	0.50	0.010	0.019

P DIP 16 = EP
PLASTIC PACKAGE
 (ML12013EP)
 CASE 648-08
 ISSUE R

NOTES:
 1. DIMENSIONING AND TOLERANCING PER ANSI Y14.5M, 1982.
 2. CONTROLLING DIMENSION: INCH.
 3. DIMENSION L TO CENTER OF LEADS WHEN FORMED PARALLEL.
 4. DIMENSION B DOES NOT INCLUDE MOLD FLASH.
 5. ROUNDED CORNERS OPTIONAL.

DIM	INCHES		MILLIMETERS	
	MIN	MAX	MIN	MAX
A	0.740	0.770	18.80	19.55
B	0.250	0.270	6.35	6.85
C	0.145	0.175	3.69	4.44
D	0.015	0.021	0.39	0.53
F	0.040	0.70	1.02	1.77
G	0.100 BSC		2.54 BSC	
H	0.050 BSC		1.27 BSC	
J	0.008	0.015	0.21	0.38
K	0.110	0.130	2.80	3.30
L	0.295	0.305	7.50	7.74
M	0°	10°	0°	10°
S	0.020	0.040	0.51	1.01

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